Vol. I September, 1916 No. 9

CATALOGUED
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MONTHLY BULLETIN

OF THE

OHIO
Agricultural Experiment Station

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of the

Ohio Agricultural Experiment Station

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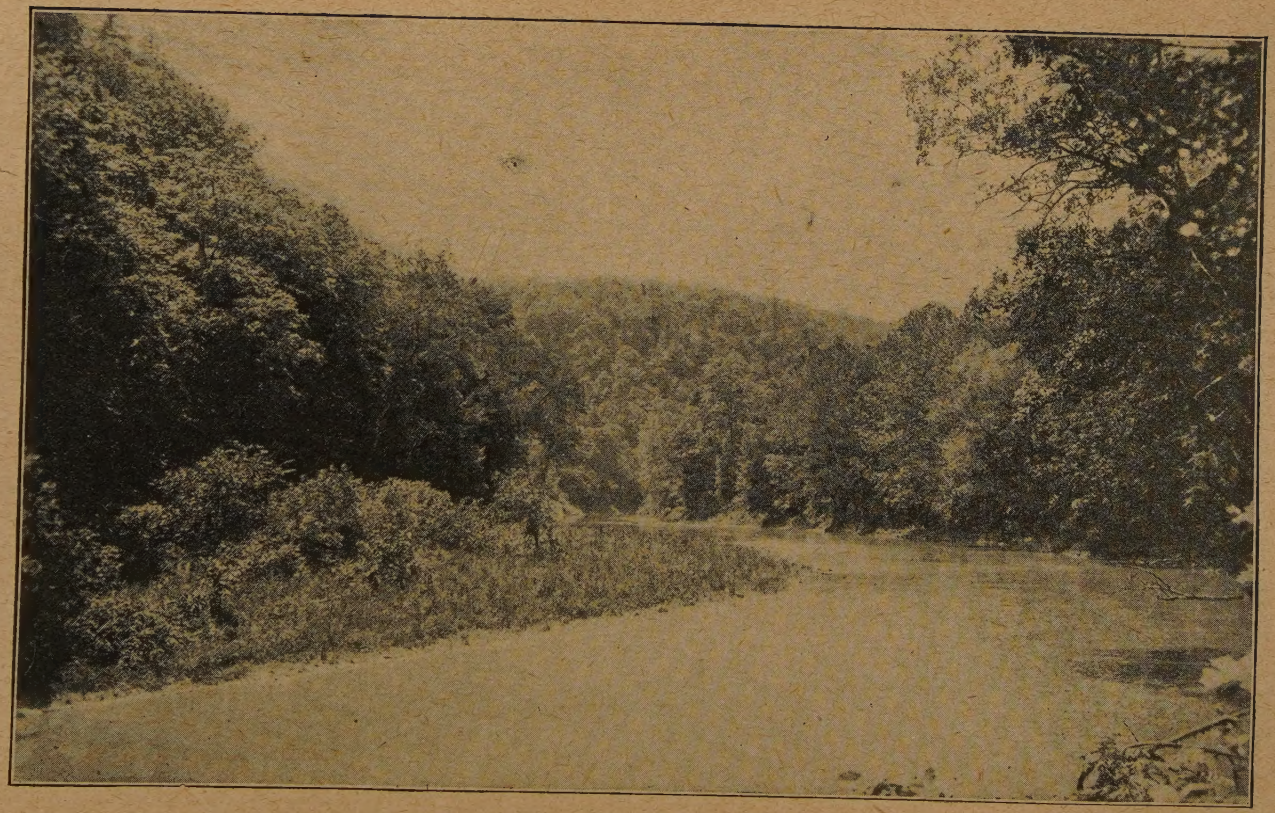

A pleasing view along Clear Fork in Ashland County

MONTHLY BULLETIN

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VOL. I SEPTEMBER, 1916 NO. 9

THREE IMPORTANT INTERNAL PARASITES OF SHEEP[1]

D. C. MOTE

At this season of the year losses due to the effects of parasites of sheep are likely to be heavy. Three of the more prevalent and damaging of the parasites that affect sheep are discussed here. In Bulletin 280 are described a number of other parasites that affect Ohio farm animals.

THE STOMACH WORM

Description.—Stomach worms (*Haemonchus contortus*) have long been recognized as one of the serious pests with which the sheep raiser has to contend. The stomach worm has also been called the "twisted wire worm" and the "striped worm." The first name indicates its location, that is, the fourth stomach; the others refer to the appearance of the worm.

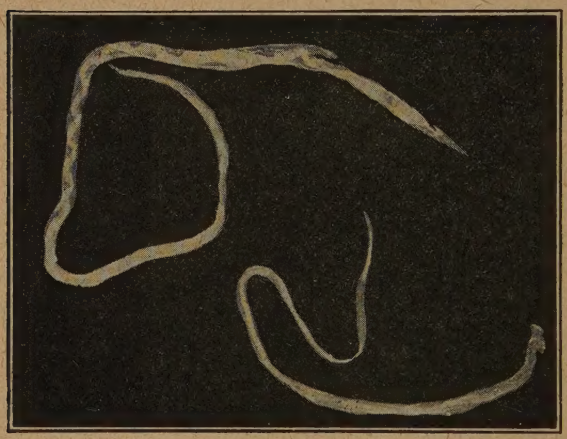
The male worm measures about three-fourths of an inch long when mature, and has at the posterior end a characteristic bilobed clasping organ. The female measures 1¼ inches and is easily recognized by a characteristic spiral striping. Both worms are red.

The following information relative to the life history is taken from Ransom (1906). The adult worms are found in greatest abundance in the fourth stomach. The female produces large numbers of eggs which pass out with the droppings. These eggs hatch in about 2 days, depending upon the temperature and moisture conditions. The very minute larva, after leaving the egg, begins to feed and grow. In from 10 to 14 days it reaches what is called the ensheathed stage, in which the former outer skin completely encases the larva. It is now prepared to wait for its host. Previous to this stage the eggs and the young larvae were easily killed by low temperatures and drouth. The ensheathed larva is very resistant.

[1]Extract from Ohio Agr. Exp. Sta. Bul. 280.

It no longer feeds. During warm, wet weather, and while the dew is on the grass the ensheathed larva crawls up the blades of grass, and sheep and cattle grazing upon the grass take the waiting larva into the stomach where it develops into an adult worm.

Symptoms and diagnosis.—The most serious effects of stomach worms are observed in lambs. When infested with stomach worms they show indications of digestive disturbances and malnutrition. The appetite becomes capricious, and the animal loses strength. Diarrhea often develops. If an animal is heavily infested, anemia, loss of flesh and general weakness soon appear. The anemic condition is indicated by pallor around the mouth and eyes, and by the development of watery swellings under the lower jaw. A surer method of diagnosis consists in killing one of the flock and opening the fourth stomach. If the worms are present in large numbers, they may be observed moving about in the fluid, and on the walls of the stomach under the numerous folds. When these symptoms are present in the flock or stomach worms are found, drenching is to be recommended.



Sheep stomach worm. Male, smaller worm; female, larger worm, enlarged about 5 times.

THE TAPEWORMS

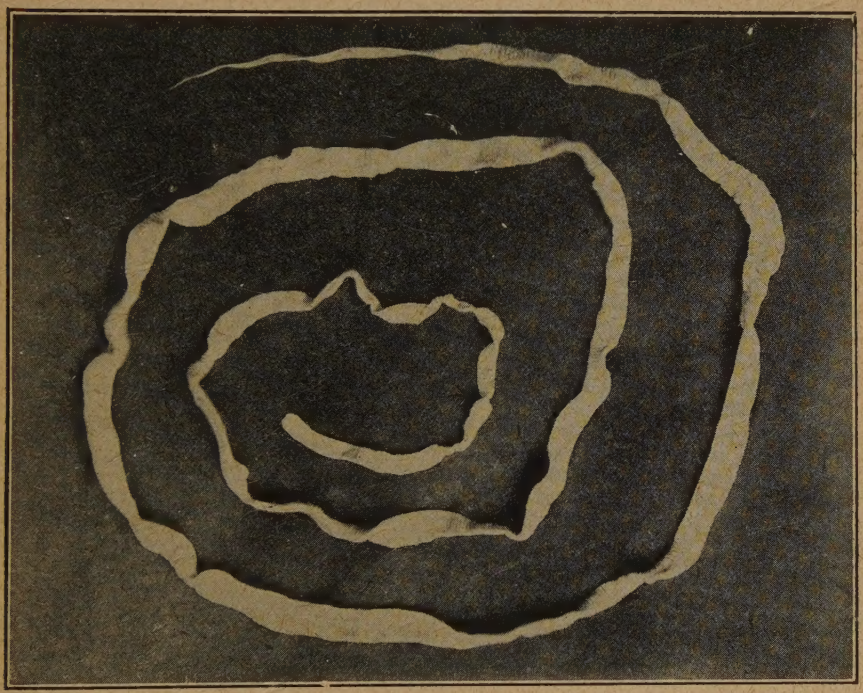
Tapeworms have not received the notoriety of the stomach worm, yet they, too, are doing considerable damage among some of the flocks of the State.

There are listed in the various books on parasites 15 different kinds of tapeworms that live in the alimentary tract of sheep. Fortunately for the sheepmen only one or two of these are common. *Moniezia planissima* has been found to be doing considerable damage to sheep, more especially lambs, of Meigs County; and *M. expansa*, a common tapeworm in other parts of the United States, probably occurs in some parts of Ohio.

The presence of considerable numbers of tapeworms in sheep may bring about symptoms similar to those described for stomach worms. Still, a more certain method of diagnosis is to look for the tiny yellowish tapeworm segments that pass out with the droppings. When these are found immediate treatment is needed.

THE NODULAR WORM

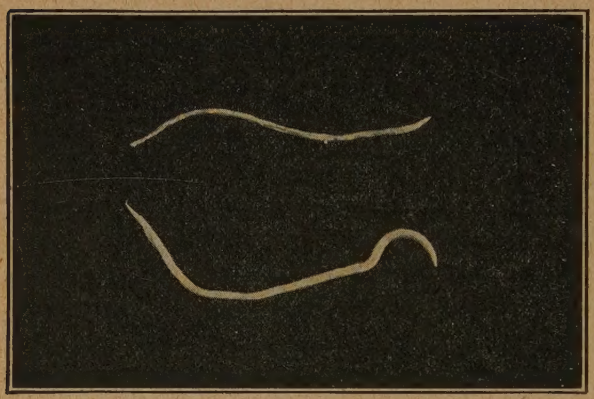
Description.—The nodular worm (*Oesophagostomum columbianum*) in the adult stage is found in the large intestine of sheep. The embryos, or younger stages of the worm, are found in nodules



A sheep tapeworm (*Moniezia planissima*) about one-third natural size.

mostly in the mucous lining of the intestines. For this reason the worm is commonly known as the nodular worm. The female attains a length of about five-eighths of an inch; the male is a little shorter. The worms are solid white in color, which distinguishes them from most other sheep parasites, some being partly translucent, yellowish or red. This worm has been likened to a hook, since its head end is usually bent over.

The life history of this worm is only partly known. The eggs pass out with the droppings. What happens from this time until the embryos are found in the nodules is not fully known. The embryos are at first inclosed within a cyst in the nodules. Later they escape from the cyst and live in the cheesy matter in the nodule. Still later they escape from the nodules and attain maturity in the large intestines. Some investigators state that the nodule stage is not essential in the development of this worm; that the worm may reach maturity without penetrating the intestinal wall. Other investigators believe that normally the tiny worms penetrate the intestinal wall, the nodules being formed only when they penetrate too deep, or when pathogenic bacteria are introduced into the intestines.



Sheep nodular worm. Male, lower worm; female, upper worm, enlarged about 3 times.

Dosing does not seem to affect the tiny worms found in the nodules, nor does it reach the adult worms located in the lower bowels.

METHOD OF TREATMENT

The round worms and tapeworms which live in the fourth stomach or in the small intestine may be expelled by the use of various drugs. Among those most generally recommended are coal tar creosote, gasoline and bluestone.[1]

The bluestone (copper sulphate) treatment was first used by government veterinarians in South Africa. Later it was introduced into the United States by the Bureau of Animal Industry, U. S. Department of Agriculture. The Ohio Experiment Station, after trying several remedies, has adopted the bluestone treatment and has been using it for 5 years. It is believed that this treatment when properly administered is less injurious, more speedily given and more effective against stomach and intestinal worms than is gasoline or coal tar creosote.

[1]See Ohio Agr. Exp. Sta. Bul. 117 for a discussion of the gasoline treatment, and Circular 102 of Bur. An. Ind. U. S. Dept. Agr. for the coal tar creosote treatment.

Preparation of copper sulphate solution and size of dose.—Dissolve 1 ounce of copper sulphate (bluestone) in 2 quarts of water and give to each individual a dose as follows:

For a lamb 3 months old give ⅔ of a fluid ounce (20 c. c.)
For a lamb 6 months old give 1⅓ fluid ounces (40 c. c.)
For a yearling give 2 fluid ounces (60 c. c.)
For sheep 2 years old give 3 fluid ounces (90 c. c.)

In making up the solution only clear blue crystals should be used. Those with white patches or crusts should be rejected. The crystals may be placed in a cloth bag and suspended in water over

Small portion of intestine of sheep, showing heavy infection with nodular worm.

night. By morning they are generally completely dissolved. It is of the utmost importance to be accurate in weighing the bluestone and measuring the doses, for too strong a solution will kill the sheep and too weak a solution will not be effective. Another important item is to keep the solution well stirred during the time it is being administered.

Preparation of the sheep.—The sheep should be kept from food for 18 to 24 hours before treating. If on pasture they may be brought in on the afternoon of the day before they are treated. On the day they are treated they should receive no water either before or after treating.

Dosing.—When the sheep have been fasted a sufficient length of time, they are driven into a small inclosure so as to be readily caught and treated. A gate should be near by through which they may be let into an empty pen as they are treated.

In dosing, a long-necked bottle or a drenching tube may be used. If a bottle is used, the dose may first be measured out and poured into the bottle, and the point reached by the liquid marked on the outside of the bottle with a file, so that subsequent doses may be measured in the bottle. Or each dose may be first measured in a graduated flask and then poured into the bottle.

Ransom describes a simple form of drenching tube, which consists of a piece of rubber tubing about 3 feet long and ½ inch in diameter, with an ordinary tin funnel inserted in one end and a piece of brass or iron tubing 4 to 6 inches long and of suitable diameter inserted in the other end. In use the metal tube is placed in the animal's mouth between the back teeth. The dose is poured into the funnel, which is held by an assistant or fastened to a post. The flow of the liquid through the tube is controlled by pinching the rubber tubing near the point of union with the metal tube.

Position of animal.—The simplest way of holding the animal has been demonstrated as the most effective. The animal standing on all fours is held between the legs while the mouth is opened with one hand, which at the same time holds the head so that the nose is not raised higher than the level of the eyes; while the drenching bottle is inserted and held in position with the other hand. With the sheep and medicine easy of access, one experienced man can treat from 40 to 60 sheep per hour.

Overdose.—Should any of the sheep receive an overdose, indicated by lying apart from the rest of the flock, purging and showing symptoms of pain, it is recommended that they be placed in a shady spot and given a teaspoonful of laudanum in a tumblerful of milk.

After treatment.—It is advisable to keep the animals in dry lot from 24 to 36 hours (preferably the latter) after treatment. Usually the medicine and the worms begin to appear in the droppings about 18 hours after dosage. It is thought best that all this material be kept off the pasture.

Time of treatment.—As stomach and intestinal parasites of one kind or another occur in most flocks, it seems advisable to adopt the plan of treating the sheep as they are brought from the pasture in the fall, again in the spring after they have been on pasture for a short time (say early in June), and at any other time during the summer that the sheep show symptoms of parasitic attacks. Of course, this plan need not be followed if the flock is thrifty, in good condition, and not infested with parasites.

THE WHITE MARKED TUSSOCK MOTH[1]

(*Hemerocampa leucostigma* Abb. and Smith)

H. C. YINGLING

Among the numerous pests of shade and ornamental trees, the white marked tussock moth is conspicuous, both as to the damage it does and as to the insect itself. The egg stage is the most conspicuous, these being deposited on the cocoons and overlaid by a stiff, white froth which acts as a protection. This also serves to distinguish them from the eggs of nearly related moths. The greater part of the egg masses are found within 10 to 12 feet from the ground, on the trunks or main branches of trees. When the trees have shed their leaves in autumn these white masses are especially easy to detect, but along toward spring they become a dirty gray in color.

Description.—The newly hatched caterpillar is yellowish white in color, with two brown stripes along the back. The body is covered with long, irregular hairs, entirely out of proportion to the size of the insect. As the caterpillar grows and molts it assumes more and more the characteristics of the full-grown caterpillar, which is a very beautiful creature. The body is hairy and of a bright yellow ground-color, striped with black. The head is coral red. Tufts of long hairs at various places on the body are distinguishing characteristics. Two plumelike tufts of black hairs extend up and forward from the thorax just back of the head, while a similar one is found at the extreme end of the abdomen. Starting a little behind the first-mentioned tufts is a row of four tufts of creamy white hairs. These tufts bear close resemblance to tiny, neatly trimmed paint brushes. In a line with these, but farther back, are two small, bright red tubercles. These tufts and tubercles are arranged along a broad black stripe down the middle of the back.

The pupa bears little resemblance to the caterpillar, or larva. It is short and thick, and almost free from hairs. The color varies from greenish yellow to black. The pupa is formed within a loose cocoon of yellowish silk, with which are mixed the hairs from the caterpillars.

The adults are of moderate size, the male having a wing spread of about 1.25 inches. The general ground-color of the wings is a grayish brown, the front pair being crossed by dark, wavy bands. Near the hind angle of the wing is a small white crescent from

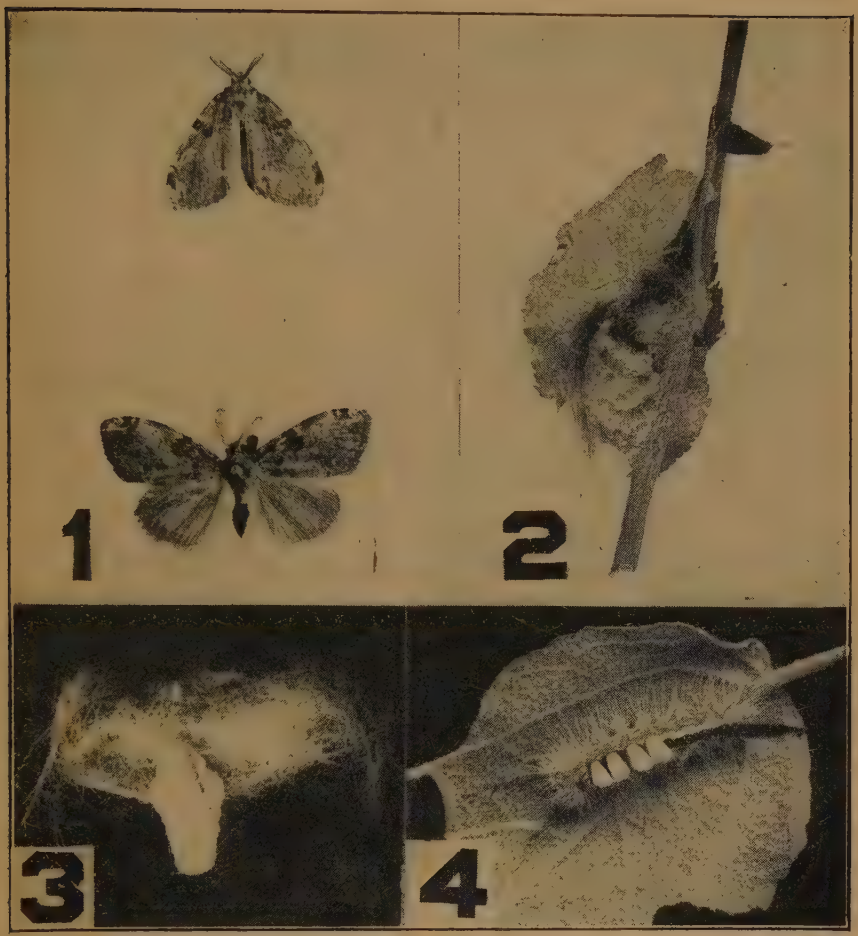
[1]Abstract from thesis submitted at the Ohio State University, 1916.

which the moth takes its name, *leucostigma*. The female is grayish white in color, wingless, and resembles anything but a moth. The body is always distended with eggs, making it very unwieldy in action.

Occurrence.—The white marked tussock moth is characterized as the most destructive leaf-eater infesting shade trees in our larger cities. It is preeminently a pest of municipalities, though it is often found in villages. The injuries are more or less periodic, but occur throughout a fairly clearly defined district. It is confined to cities because of the abundance of English sparrows which drive away its natural enemies, the songbirds. Moreover, the sparrow will not eat the hairy caterpillars; hence, the moth is practically undisturbed.

The moth is a native of North America, and ranges from Jacksonville, Fla., along the Atlantic coast to Nova Scotia, extending west certainly as far as central Iowa, while it has been reported from Omaha and Lincoln, Neb. The western limit, apparently, is the edge of the forested area. It ranges southward to the states bordering the Gulf of Mexico. The pest is common practically everywhere within these limits. Definite reports have been made from many cities in Ohio, including Cleveland, Cincinnati, Toledo, Columbus, Youngstown, Akron, Canton, Alliance, Elyria, Tiffin, Fremont, Chillicothe, Painesville and New Philadelphia. For these reports the writer is indebted to J. S. Houser, of the Ohio Experiment Station, J. M. Robison, of the Ohio State University, and various other students who have encountered the moth and its work. The reports are sufficiently common to establish the importance of the pest in our Ohio cities.

Since the females are wingless, flight plays no part in the spread of the pest. The principal means of spread is by the migration of caterpillars from tree to tree. This occurs only in the case of nearly full-grown larvae, which are good travelers. There may be two reasons for such migration—the complete defoliation of the tree or a sort of instinctive "wanderlust" which seizes the caterpillar when ready to pupate. These methods suffice, however, for only short distances. The caterpillars, when newly hatched, spin long silken threads, by which they hang down when the food plant is jarred. Here they may be brushed into by moving objects and carried long distances, or they may be picked up by the wind and carried to more or less distant points. But the surest method of long-distance spread is by the shipping of nursery stock, stones, etc., with egg masses attached. These means of dispersal lend themselves readily to control measures.



The white marked tussock moth.

1.—Adult male, natural and spread positions; 2.—Egg mass on cocoon; 3 —Adult female on cocoon; 4.—Full-grown caterpillar.

Life history.—In latitudes north of Boston, Mass., there is one brood of the moth annually. Between Boston and Washington, D. C., there are two broods annually. South of Washington there are three broods annually. Ohio thus falls in the two-brood belt, with almost a certainty of three broods in the extreme southern part of the State.

The over-wintering eggs hatch during the first 2 weeks of May. About a month is the normal requirement for the complete growth of the larvae, during which period they molt five times. The full-

grown caterpillars crawl down to the trunk or main branches of the trees to spin the cocoons, often crawling to fences, buildings or other trees. This takes place usually from the middle of June to the first of July. The pupal, or chrysalis, stage lasts about 2 weeks, the moths emerging throughout the first 2 weeks of July. The males emerge first and fly about until the females emerge. Mating takes place upon the cocoon of the female, and here the female lays her eggs. As neither sex of the adult takes any food whatever, the male dies after mating and the female as soon as the eggs are deposited.

These eggs hatch in about 2 weeks, and the remainder of the life cycle is the same as that of the first brood, excepting that the eggs, which are deposited in September and early October, remain over the winter before hatching.

Damage done by caterpillars.—In Columbus, the principal food plants are poplar, soft maple and the elms. In Cleveland, willows are added to the list. Reports show injury to alder, birch, apple, box-elder, hard and Norway maples, oak, ash, hickory, catalpa, sycamore, dogwood, Viburnum, bladdernut, linden, horse chestnut, buckeye, apricot, garden and wild plum, cherry, chokecherry, rose, pear, quince, butternut and black walnut.

The damage is similar to that done by any leaf-eating caterpillar, often extending to complete defoliation of the trees. In rare cases, the soft bark is eaten from young twigs. These may be girdled, which causes them to drop off. Such injuries to trees are exceptionally important in cities. Civic pride in trees is well shown by the popular name that Clevelanders give their home, "The Forest City." Thus this insect is at once seen to be of immense importance.

Some reports of physiological injury to man are worthy of notice. The hairs of the larvae are barbed, and being very brittle are easily broken off. In the skin they cause a dermatitis not unlike that of poison ivy. In the membranes of the eye, they cause painful hardenings or knots, requiring the attention of an occulist. This form of injury, however, is rather uncommon.

Parasites.—The white marked tussock moth offers a good field for the study of parasitism in insects. The parasites occur in such numbers at times as to effect almost complete control of the pest. Prof. S. A. Forbes, of Illinois, had some students working on this problem during the season of 1907. They found that 75 percent of the pupae in Chicago were killed by parasites. These, however, did not control the pest, and there was a serious outbreak in 1908.

The parasites are of two general classes—primaries, which work directly on the pest, and hyperparasites, which kill the primaries and thus let the pest go free. In some cases the primary parasite is attacked by a secondary, while the secondary parasite is subject to a tertiary, and in a few cases, the tertiary parasite is attacked by a quaternary, or fourth degree, parasite. The primaries and tertiaries are effective in the control of the moth, while the secondaries and quaternaries are favorable to its increase. Dr. L. O. Howard, of the Bureau of Entomology, lists 21 primary parasites of this moth, 15 of which are Hymenoptera, or parasitic wasps, and 6 are Diptera, or flies. He also lists 14 hyperparasites, all Hymenoptera, including secondary, tertiary and quaternary parasites.

Ichneumon unifasciatorius

Ichneumon seminiger

Two primary parasites of the white marked tussock moth, enlarged about 3 times.

The principal primary parasite is the little *Pimpla inquisitor*. This insect is commonly attacked by a secondary parasite, *Dibrachys boucheanus*. In addition to the more common ones, the writer reared a specimen each of two primary parasites not recorded by Dr. Howard. These large, showy wasps, *Ichneumon unifasciatorius* Say and *Ichneumon seminiger* Cresson, are figured in this bulletin.

In addition to the parasitic insects, two beetles of the family Dermestidae are known to feed upon the eggs of the moth. Several of the predaceous stink bugs feed on the caterpillars and thus effect some control of the pest, though in general the work of predaceous bugs is not noticeable.

Control.—The first step in indirect control is the extremely useful one of exterminating the English sparrow. This allows the native birds to nest freely, and the double advantage of gaining their song and of controlling the pest is at once evident. The robin,

Baltimore oriole and cuckoo are the most important enemies of this moth, while E. H. Forbush lists 44 other birds which feed, at least in part, on hairy caterpillars.

Care in planting trees little affected by insects will work slowly but well. The tulip tree, ginkgo, horn-beans, alders and magnolias are all more or less resistant to insects in general and to defoliating insects in particular.

Direct control is easily effected. Poison sprays, of which arsenate of lead is the best, are effective in large cities. The spraying rig necessary for tall trees is rather costly, however, and can be used only in large municipalities. The arsenate may be used in proportions of from 3 to 5 pounds to 50 gallons of water, the stronger applications being used in emergencies where quick work is necessary. Paris green may be substituted for the arsenate, but is likely to burn tender foliage. Spraying is within the reach of property owners only when the trees are small. Otherwise it must be a municipal practice.

Banding the trees with some sticky substance, such as tanglefoot, catches the caterpillars as they crawl down to pupate or to go to other trees.

Painting the egg masses with creosote is at once easy and effective. This is done with a small sponge attached to a long pole. The masses are saturated with creosote, which kills the eggs and thus prevents their hatching.

Removal of egg masses is the most thorough, cheapest and easiest method of control. The white egg masses are most conspicuous objects on the bark of trees, especially in autumn, when the leaves no longer hide them. A small hoe-blade attached to a pole of medium length and a wire hook on a longer pole are all the tools necessary for the work of removing egg masses.

If all the egg masses are removed from the trees and burned, and the trees banded in the spring to prevent the invasion of stray caterpillars from untreated trees, control will be absolute. The advisability of removing cocoons is questionable, as many parasites which would aid in control are destroyed along with the pest. It would seem better to allow the moth to emerge and then destroy the eggs, allowing the parasites to emerge unharmed.

Because of the simplicity of the control methods, the widespread devastation of the white marked tussock moth is really unnecessary.

THE USE OF THE SCORE CARD IN POTATO JUDGING

S. N. GREEN

Potato judging is attended with many difficulties, because great diversities of opinion exist with regard to standards and ideal characteristics sought. The judge cannot expect to place exhibits to the satisfaction of all in every instance, and yet he should be able to give reasons to substantiate every placing made or every point awarded. Before he attempts to place any entries, therefore, he should have a clear understanding of the standards set by well-known authorities and then fix in his own mind certain requirements upon which the entries can be rated.

In fixing the type in mind the judge can profit by a study of the score card. It is not to be understood, however, that the score card alone can be used as a basis for judging. The experience and ideals of the judge constitute the final court of appeals in the awarding of premiums.

OHIO POTATO SCORE CARD[1]

The following score card has been suggested to meet the demand from such work:

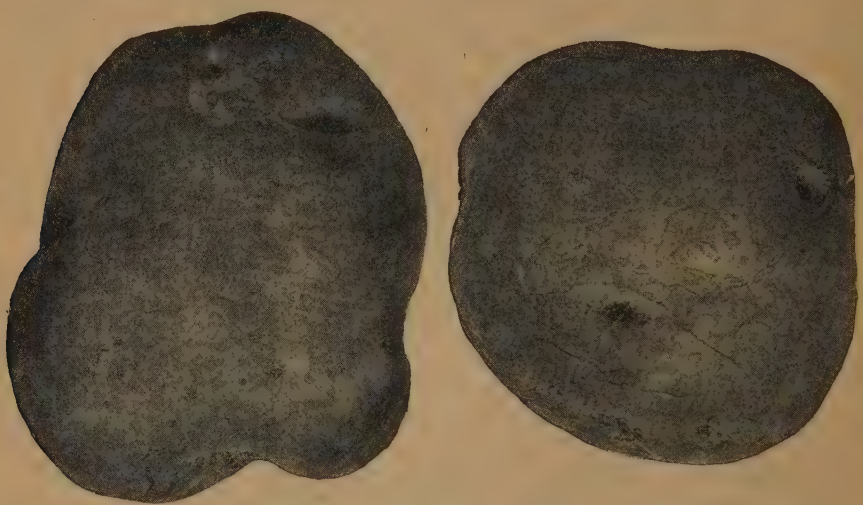
	Points	Score
Trueness to type	25	
Uniformity of size and shape	25	
Condition as to diseases and blemishes	25	
Color and texture of skin	10	
Depth and frequency of eyes	15	
Total	100	

Trueness to type.—Because of the mixture and misnaming of the many varieties of potatoes now commonly grown in Ohio, it is necessary that the judge know just what constitutes the true type of any variety and then grade accordingly. Since tubers vary greatly within pure strains, in many cases due to conditions of environment, considerable training is necessary to determine whether an exhibit is true to type. The identification of the common groups in Ohio was discussed in the August Monthly Bulletin.

Uniformity of size and shape.—The potatoes in every exhibit should be as uniform in size and shape as it is possible to select, because few things detract more from the appearance of an exhibit than a mixture of large and small tubers of various shapes. Abnormal size is of no value from a commercial or seedman's standpoint,

[1] A limited number of these score cards printed upon convenient-sized slips are available upon application to the Horticultural Department of this Station.

despite the favorable comment usually given to large potatoes at fairs. Judges should warn against the tendency to select extremely large tubers, and should recommend some standards to which requirements exhibitors can reasonably conform. These standards necessarily are arbitrary and vary with the variety. Thus the Triumph and Pearl groups are 3 inches long; Cobbler, Early Ohio, Rural and Peachblow groups are 3½ inches long; the Green Mountain group is 4 inches, while the Early Michigan, Rose and Hebron measure 4½ inches, and the potatoes in the Burbank group should average 5 inches. Tubers of any variety should not vary more than one-half an inch either way from these standards.



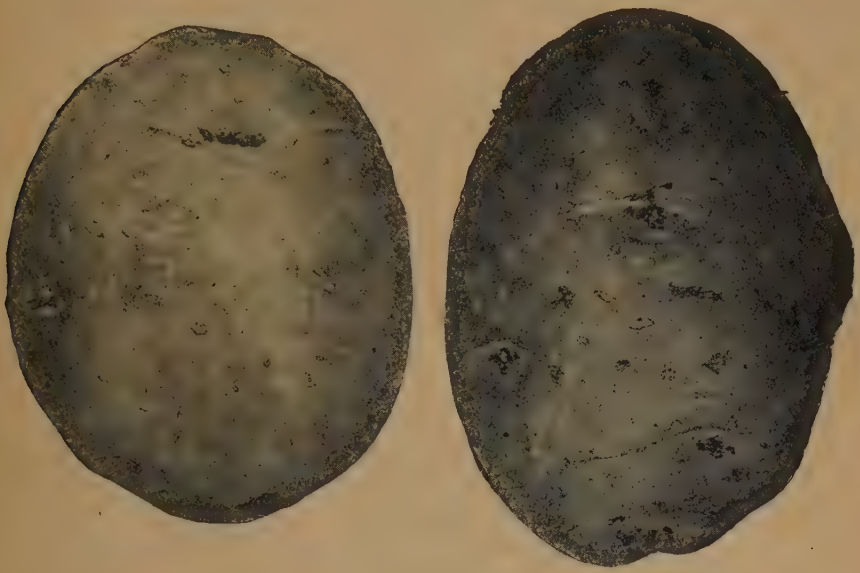
Typical specimens of the Cobbler and Triumph groups.

Uniformity in shape is equally important. In this connection judges should discriminate against potatoes having a pointed seed-end or those with prominent eyes.

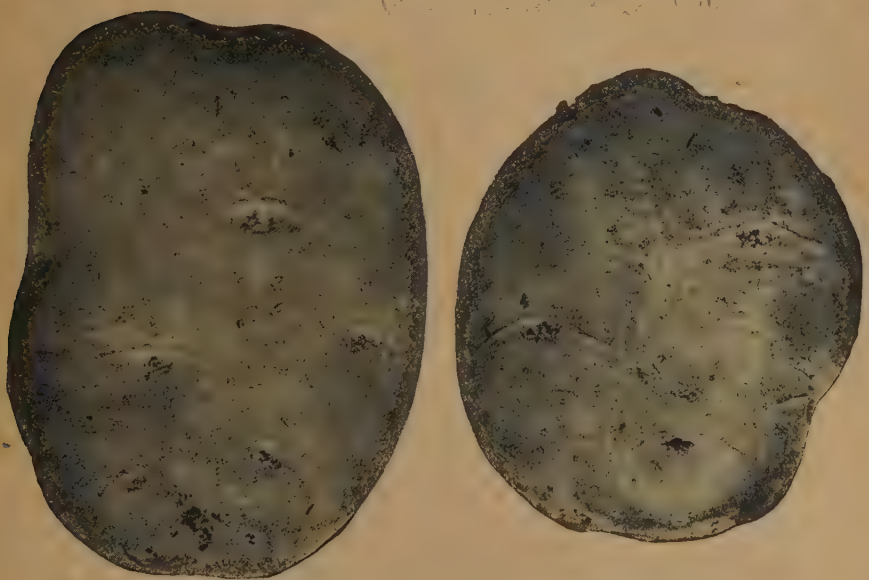
Condition as to diseases and blemishes.—Signs of such diseases as scab, blight, rhizoctonia, wilt or rot lower the score materially. Cuts, bruises and other blemishes lessen the attractiveness of the exhibit.

Color and texture of skin.—The conditions under which the specimens have been grown are shown in a general way in the color and texture of the skin. A smooth, bright skin shows favorable environment and treatment, while a rough, stained, broken skin indicates unsuitable conditions or immaturity. Green tubers are undesirable. Firmness of flesh is an indication of storage conditions. Hollowness and stained or flabby flesh are serious objections.

Depth and frequency of eyes.—After allowance is made for varietal characteristics, the potatoes having shallow and few eyes are most desirable. A malformed or protuding eye makes the tuber less valuable for seed and should be discounted on the score card.



Typical specimens of the Early Ohio and Hebron groups.



Typical specimens of the Green Mountain and Rural groups.

FIRE-BLIGHT INVESTIGATIONS

H. A. GOSSARD AND R. C. WALTON

For two seasons the writers have worked cooperatively on various problems concerning fire-blight of the apple and pear. From the results obtained we summarize as follows the answers or partial answers we have obtained to three questions; viz:

1. How long and under what conditions will the fire-blight organism, *Bacillus amylovorus*, live in aphid honey dew as it occurs among aphid colonies on leaves of fruit trees?

2. Will the blight organism live for any significant length of time in the nectaries of other flowers than apple, pear and quince, such as peach, plum and cherry?

3. How long will the bacilli[1] live in honey?

Life of bacillus in honey dew.—From the fact that aphid honey dew is visited by great numbers of flies, ants, wasps and bees of various kinds, its capacity for sustaining the life of the bacilli is necessarily of much interest. We had excellent material with which to work in the Station entomological and botanical greenhouses. This consisted of young potted apple trees badly infested with the apple aphis, *Siphocoryne avenae*.

Two leaves were selected for this study. On the upper side of one, which was not curled but in a horizontal position, was a large drop of honey dew at the basal end. This honey dew came from aphids on a tender, overhanging shoot directly above. On the under side of the other, which was curled, were two large drops, and these were continually added to by the presence of aphids above the drops within the curled leaf. Honey dew was collected in small quantity in a 1 cubic centimeter pipette from trees close by and to the drops on the two leaves was added sufficient honey dew to form one large drop on each leaf.

The two leaves were then separately infected with a 9-day-old culture of the fire-blight organism, one at 2.30 p. m. and the other at 2.55 p. m. on April 24, 1916. Each was inclosed in a paper bag to prevent rapid evaporation of the drops. Check inoculations were then made into tender apple tips with this same culture in order to prove beyond question its identity. These inoculated shoots subsequently became infected, while sterile incision checks made at the same time remained free. Sterile incision checks were made with a sterile scalpel into tips similar to those used for inoculation.

[1]Bacilli—The plural form of "bacillus," the minute organism causing fire-blight.

Every day for 10 days, or until May 4, inoculations were made from the infected honey dew drops into healthy apple shoots, and check inoculations consisting of sterile incisions were made at the same time.

The honey dew drops slowly evaporated until at the end of 5 days they were only moist in the mornings and dry the remainder of the day. The seventh day showed them to be completely dry. A small quantity of sterile water (two or three small drops) was then added each day, after the seventh, to the place where the honey dew had been, this being kept up until the end of the tenth day.

Results taken May 19 showed 100 percent infection of all inoculations with the infected honey dew, while all checks remained free. In other words, the blight organism can live in honey dew for 7 full days until the dew has completely dried, and then for 3 more days, or perhaps longer, when moisture is added.

Life of bacillus in peach, plum and cherry blossoms.—We have thus far experimented only with peach, plum and cherry blossoms in connection with Question 2. It is desirable, of course, to conduct similar tests with many or all of the blossoms which are open during the same period as blossoms of the apple, pear and quince.

A water suspension of the blight organism was made by washing a 2-day-old culture of the organism with sterile distilled water into a 100 cubic centimeter flask. Inoculations were made May 9 and 10 by means of a camel's-hair brush into 13 peach (Connet's Early and Arp Beauty), 16 plum (Missouri apricot) and 11 cherry (Montmorency) blossoms, the water suspension being used as the inoculum.

Approximately every 24 hours thereafter, specimens of these inoculated whole blossoms were taken, the petals cut off with sterile scissors and the calyx cups cut into small parts into a sterile receptacle. These parts were then used as the inoculum in inoculating tender apple shoots. The test extended over 5 days, and altogether 85 inoculations were made from the peach and 45 each from plum and cherry. Practically as many checks were made as inoculations.

Records taken May 26 showed an average of 64½ percent infections from the peach blossoms, 74 percent infection from the plum and 94 percent from the cherry. The checks, consisting of sterile incisions, all remained free.

These results mean that the blight organism is capable of living in peach, plum and cherry nectar for 5 full days or probably more,

and during this period can be disseminated from these blossoms to hosts susceptible to blight infection, provided the bacilli have been left there by pollinating insects.

Life of bacillus in honey.—The problem of the life of the bacillus in honey was studied during the spring of 1915 and the results were published, but the writers felt that the work was not carried sufficiently far to obtain optimum results.

On May 9, 1916, during the apple-blossoming period, a 5 cubic centimeter sample of honey was taken from the hive by means of a large sterile pipette. This sample, just as it came from the hive, was infected with a 2-day-old culture of the blight organism at 8.40 a. m., May 10. The organism was thoroughly mixed with the honey, which was of a light-colored, watery consistency.

For 9 days, or from May 11 to May 19 inclusive, inoculations were made from this infected honey into the tips of healthy, tender apple shoots, a sterilized scalpel being used to inoculate shoots and 200 inoculations and 205 checks being made. All were protected with paper bags, which had been placed over the twigs in early spring before the leaves appeared.

Records taken May 26, 1916, showed that at the end of 30 hours 95.8 percent of the inoculated twigs became infected; at the end of 53¼ hours 33½ percent, and at the end of 72 hours 28 percent. Every check remained perfectly healthy.

The maximum life of the organism in honey may exceed 72 hours, but it can hardly be many hours greater than this. From all the evidence we possess, we would be much surprised to find it living longer than 100 hours.

IDENTIFICATION OF CLOVER LEAF TYER

H. A. GOSSARD

Through an unintentional oversight we failed in Bulletin 297 and in the June Monthly Bulletin to acknowledge our obligation to Dr. C. H. Fernald for establishing beyond question the identity of the clover leaf tyer, *Ancylis angulifasciana*. Dr. Fernald has in his possession some of the moths used by Zeller in writing the original description and found our moths to be the same. We think it important that this be recorded.

LIMING THE WHEAT CROP

C. E. THORNE

The winter of 1915-16 was a severe one on late-sown wheat and on that sown on flat, undrained land. Over much of the State the harvest has yielded much below the average. On the rolling, well-drained land at the Experiment Station and in the immediate locality the yield has been good, although one may find flat, wet fields within a few miles that have yielded not more than half a crop.

In the 5-year rotations, at both Wooster and Strongsville, some interesting results have been attained. At Wooster the wheat grew this year on Section "D," the east side of which has never had any lime, while the west side was limed in the fall of 1903 and in the spring of 1909 and 1914, the lime being applied to corn 2 years before the wheat was sown. In 1903 fresh burnt lime was used at the rate of a little less than 1,000 pounds per acre, the lime being applied in October and plowed under the next spring for corn. In 1909 ground limestone was used at the rate of 1 ton per acre, being spread on the surface after plowing and harrowed in before the corn was planted; and in 1914 ground limestone was again applied in the same manner, but at the rate of 2 tons per acre, our observation having convinced us that the previous applications had not been sufficiently large to produce the best results.

Yields on unfertilized land.—The wheat crop of 1906 was an exceptionally good one at the Station, the average unfertilized yield on the unlimed land in this experiment reaching 17 bushels per acre, as against an average for the previous 12 years of 8.6 bushels; but on the limed end the yield reached nearly 24 bushels: a gain of nearly 7 bushels for the lime given to the previous corn crop.

In 1911 the unfertilized and unlimed wheat in this section averaged 4.45 bushels, as against 8.78 bushels on the limed land, the yield generally being below the average that year. To state the outcome in another form, the wheat grown on unfertilized land was increased by the lime applied to the previous corn 41 percent in 1906 and 97 percent in 1911, and the table below shows that it has been increased by 106 percent in 1916.

Year	Total yields per acre		Increase for lime	
	Without lime	With lime		
	Bushels	Bushels	Bushels	Percent
1906	17.02	23.98	6.96	41
1911	4.45	8.78	4.33	97
1916	10.59	21.80	11.21	106

Yields on fertilized land.—Acid phosphate, applied at the rate of 160 pounds per acre to wheat, following applications of 80 pounds each to corn and oats in the same rotation, has produced the following effects:

Year	Total yields per acre		Increase for lime	
	Without lime	With lime		
	Bushels	Bushels	Bushels	Percent
1906	27.42	34.00	6.58	24
1911	9.41	15.75	6.34	67
1916	16.67	27.92	11.25	67

Plot 11 in this experiment receives the same quantities of acid phosphate as Plot 2, together with muriate of potash, 80 pounds each on corn and oats and 100 pounds on wheat, and nitrate of soda, 160 pounds on each of the three crops. The yields on this plot have been as follows:

Year	Total yields per acre		Increase for lime	
	Without lime	With lime		
	Bushels	Bushels	Bushels	Percent
1906	40.08	45.33	5.25	13
1911	19.92	24.08	4.16	21
1916	29.75	36.92	7.17	21

Plot 26 receives the same total quantities of nitrogen, phosphorus and potassium as Plot 11, but the phosphorus is given in steamed bonemeal instead of acid phosphate. The record of this plot follows:

Years	Total yield per acre		Increase for lime	
	Without lime	With lime		
	Bushels	Bushels	Bushels	Percent
1906	37.33	41.00	3.67	10
1911	17.75	20.58	2.83	16
1916	29.17	30.50	1.33	4

The yield of the limed end of Plot 26 is abnormally low this year, but in the general average of the 11 crops of wheat which have been harvested in this experiment since the liming was begun, and which have been grown on five different tracts of land, the yield of wheat from bonemeal has been about 3 bushels per acre less than

from an equivalent amount of phosphorus in acid phosphate, although the clover and timothy crops have been larger following bonemeal than after acid phosphate.

Plots 17 and 24 receive half as much nitrogen as Plot 11, with 50 percent more phosphorus and the same quantity of potassium. On Plot 17 the nitrogen is carried in nitrate of soda, and on Plot 24 in sulphate of ammonia. The phosphorus and potassium are carried in acid phosphate and muriate of potash. The yields of these plots have been as follows:

Yields of clover on unlimed and limed land receiving no fertilizer.

	Year	Total yields per acre		Increase for lime	
		Without lime	With lime		
		Bushels	Bushels	Bushels	Percent
Plot 17	1906	37.92	43.08	5.16	14
	1911	18.55	25.75	7.20	39
	1916	27.58	36.92	9.34	37
Plot 24	1906	30.42	40.67	10.25	34
	1911	11.49	24.75	13.26	115
	1916	17.17	36.75	19.58	114

Yields on manured land.—Plots 18 and 20 receive barnyard manure, 8 tons per acre each on corn and wheat on Plot 18, and 4 tons on each crop on Plot 20. The record of these plots follows:

	Year	Total yields per acre		Increase for lime	
		Without lime	With lime		
		Bushels	Bushels	Bushels	Percent
Plot 18	1906	39.00	46.17	7.17	18
	1911	24.58	30.92	6.34	26
	1916	28.50	35.92	7.42	26
Plot 20	1906	34.33	39.83	5.50	16
	1911	18.41	22.25	3.84	21
	1916	24.33	29.58	5.25	21

As has been stated above, the lime or limestone has been applied only to the corn, 2 years before the wheat was sown. The increase in corn and in oats has paid for the liming, leaving the gain

Yields of clover on unlimed and limed land receiving complete fertilizer, with nitrogen in sulphate of ammonia.

in the wheat and in the mixed clover and timothy following as clear profit. Whether the total result would be the same were the lime applied first to the wheat crop this experiment does not show. This point is being taken up in a new series of experiments.

Conclusions.—This experiment clearly shows the fundamental importance of lime *on this soil.* Neither manure nor any combination of fertilizers has been able to produce a full yield of wheat without the help of lime.

This land is hungry for nitrogen as well as phosphorus, as shown by the yields on Plot 6, which carries the same dressing of acid phosphate as Plot 2, together with 160 pounds of nitrate of soda on each of the three cereal crops. This treatment raised the yield on the unlimed land to 36.92 bushels in 1906, and 26.08 bushels in 1916. When lime was substituted for nitrate of soda the yields were 34 bushels in 1906 and 27.92 bushels in 1916, confirming the well-known fact that one of the effects of liming is the liberation of nitrogen in the soil.

The land to which nitrogen is carried in sulphate of ammonia is showing the greatest need for lime. The unlimed yield on this land was 80 percent in 1906 and 64 percent in 1916 of that harvested from land receiving the same quantity of nitrogen in nitrate of soda, but when lime is added the yields from the two carriers of nitrogen are practically the same.

Yields of clover on unlimed and limed land receiving barnyard manure.

The moderately manured land shows the same increase for lime as that receiving the larger dressing of nitrate of soda (Plot 11), while the more liberal use of manure increases the demand for lime.

The point of greatest importance brought out in this experiment is that where the land needs lime nothing but lime will satisfy that need, and that neither fertilizers nor manure will bring the land up to its maximum capacity without the aid of lime.

A PASTURE SURVEY IN SOUTHEASTERN OHIO

H. W. HAWTHORNE[1] AND C. W. MONTGOMERY

An idea of the general condition of the pastures of eastern and southeastern Ohio may be gathered by a study of statistics in the reports of the Ohio State Board of Agriculture. These statistics show that for the year 1909 forty-five percent of the farm area in the Fifth and Seventh Farm Management Districts of Ohio was pasture land, and computations based upon these statistics show that there was but one animal unit[2] for each 4.9 acres of pasture. Data obtained in a similar manner for a single township within this area and covering the 5-year period 1907 to 1911, show that the percentage of pasture land was 65.7 of the total farm area, with an animal unit for each 7.5 acres of pasture land. A farm-management survey in the same township for the year 1912 shows more than 50 percent of the farm area in pasture, with 5.5 acres for each animal unit. Similar data in this township for the 3 years succeeding 1912 show only slight variations in the carrying capacity of its pasture land from that of the year 1912.

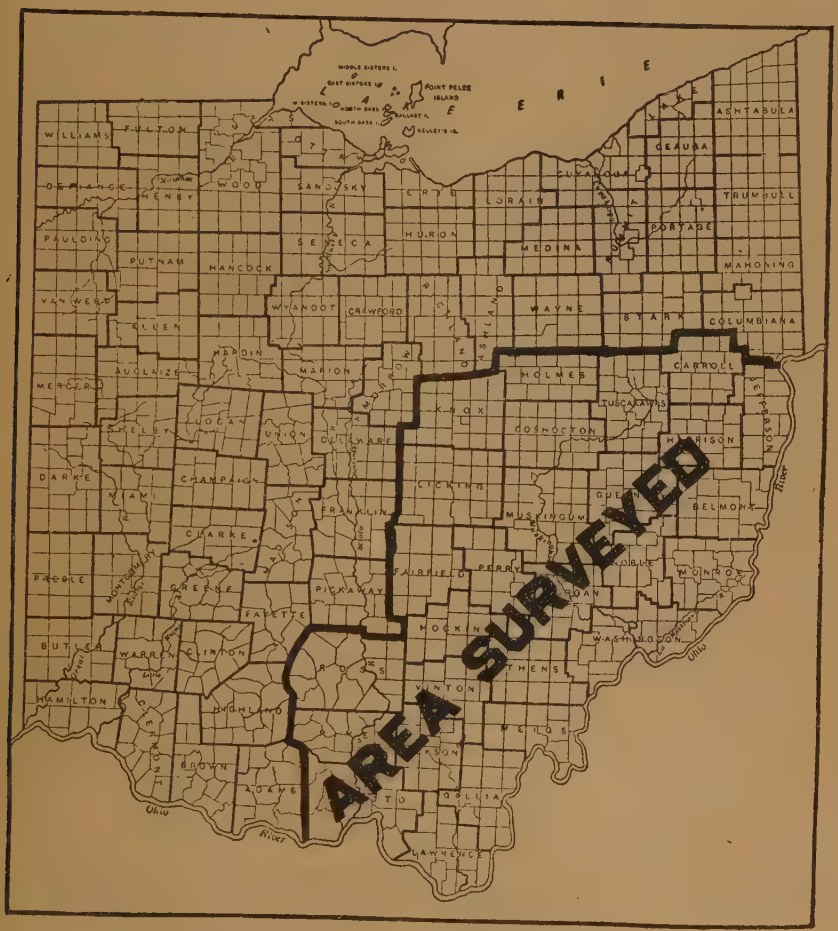
When we consider in connection with these data that the farm land without buildings within this entire area is valued at about $25 per acre and at $20 for this township, we can partly realize the importance that pasture land occupies in the organization of the farms within the region. Undoubtedly a part of this land has been profitable, but there must be a considerable portion of it that has not been.

In order to learn the prevalent practices of farmers in this area in obtaining, maintaining and improving their pastures and, if possible, to discover some systematic method or methods of increasing economically the carrying capacity of these pastures, the writers conducted a pasture investigation during the summer of 1913 within the area indicated by the accompanying map. In this investigation each county within the area and as many farms as possible in the time devoted to the project were visited. The investigation was conducted under the direction of the Department of Cooperation of this institution (since reorganized under the name of Department of Farm Management) cooperating with the office of Farm Management of the U. S. Department of Agriculture.

[1]Of the U. S. Dept. Agr., formerly with the Dept. of Cooperation, Ohio Agr. Exp. Sta.
[2]One horse, one cow, ten sheep, or five hogs, or twice the number of young stock of any given kind, are regarded as one animal unit.

METHOD OF INVESTIGATION

The initial step in the investigation was to get in touch with farmers who had considerable pasture land or who had made some attempt to improve their pastures. In order to do this a reply postal card was sent to each farmer within this area whose name



Map of Ohio showing area studied in pasture survey.

was on the Department's mailing list. Some 700 cards were sent out, of which about 60 percent were returned. These cards stated the object of the study and asked for the location, acreage and pasture area of each farm. They also asked if any attempt had

been made to improve the pasture land, what methods had given best results, and what farmers in the vicinity had attempted pasture improvement.

Those farmers whose replies indicated a large proportion of pasture land, or that they had made attempts at improving their pastures, were visited later during the investigation. These personal visits were made to some 100 farmers, and their systems of managing pasture land discussed.

In addition to the method outlined above for a pasture study, a number of experimental plots were put out in two townships within this area. This experimental work will be discussed later in this article.

ROTATION PASTURE

Rotation followed.—The prevalent rotation practiced by the farmers visited included corn followed by oats and by wheat. In the wheat were usually seeded medium red clover and timothy, which were mown for hay and pastured for an indefinite number of years, the time usually being "as long as it would last." This period varied from 1 to 9 years and included hay cutting for "so long as it would cut a good swath," which was from 2 to 4 years, and then pasture for 1 to 5 years, or "until the grass had almost or entirely run out." The land was then plowed for corn and the rotation just mentioned repeated.

Of course, there were several departures from this custom, but in the main it represents the prevalent practice of handling rotation pasture. A few of the more numerous departures from this practice follow:

In some cases oats were omitted from the rotation.

On other farms both oats and wheat were omitted from the rotation and the corn land was immediately sown to clover and timothy for hay and pasture crops.

Some farms were found on which the land was in meadow and in pasture for a fewer number of years than indicated above, not because the grass had "run out," but because these farmers considered it more economical to begin with the second rotation period before the pasture had become scant. With these farms the rotation land was in grass not less than 2 years nor more than 3 years. Our observation in comparing these meadows and pastures with those of the more prevalent and longer rotation periods was that the shorter rotation period, with meadow and pasture occupying not more than 3 years in the rotation period, is preferable.

Still other farmers following this rotation seeded clovers and grasses other than medium red clover and timothy. With the medium red clover sometimes alsike was sown and occasionally white clover. Occasionally farms were found where alsike had been substituted for the medium red. This practice was generally found on the Dekalb silt loam type where lime had never been used. The other grasses sown with or substituted for timothy were bluegrass, redtop and orchard grass. The farms where redtop was mixed with timothy or occasionally sown without timothy were on the same soil type as that mentioned where alsike was substituted for red clover.

Maintaining fertility.—Practically all the farmers in this area use commercial fertilizer. This is usually applied when the land is sown to wheat. In a few areas the practice is to use commercial fertilizer on both corn and wheat. Almost all analyses of fertilizers are used, but the 14 or 16 percent acid phosphate is probably used more widely than any other kind, with mixed fertilizers second and steamed bone third.

Manure is ordinarily applied during the rotation period. There are two distinct practices followed with reference to the time during the rotation when the manure should be applied. The one is to apply it just before plowing for corn; the other, at any time after the ground is plowed for wheat and before the growth of wheat has advanced too far the following spring.

This discussion shows the practice for nearly all rotation pasture within the area. A few deviations other than those discussed were found but were extreme exceptions.

PERMANENT PASTURE

More than half the pasture land in this area is classed as permanent pasture. Most of these pastures have been made without special seeding for that purpose. In some cases they have never been plowed and the grasses came in at will, while in others they were sown to clover and timothy and the more permanent pasture grasses and clover came in later.

Methods of seeding.—Occasionally a farmer was found who had seeded land with clover and grass with the idea of securing a permanent pasture. Some examples of the methods used by these men will be presented.

On one farm located in the Meigs series of soils a successful permanent pasture has been obtained by seeding about July 1—one bushel, or a little less, of buckwheat being used per acre in addition

to a mixture of 6 pounds of timothy, 4 pounds of orchard grass, 10 pounds of bluegrass, 6 pounds of mammoth clover and 2 pounds of alsike. At the time of seeding 200 pounds per acre of 14 percent acid phosphate was applied. This seeding showed a fine stand of grass with all prospects for a good pasture the year following.

On the same farm a worn-out pasture field was disked early in the spring and seeded with the pasture mixture just mentioned. Oats at the rate of 2 bushels per acre were sown with this mixture and cut for hay. The owner does not regard this method as being so successful as the former one.

On a clay soil containing some lime one farmer reported a regular rotation of corn, oats, wheat, clover and timothy. He does not cut the meadow for more than 2 years. If he wants permanent pasture he follows this rotation and, by adding 3 quarts of bluegrass seed per acre to the regular meadow seeding, can have a good bluegrass pasture 3 years after seeding. One field seeded in this manner showed a good stand of bluegrass the third year after seeding.

The story of seeding 5 acres on the Meigs series of soils to permanent pasture as told by the farmer is: "Six years ago the field after being in corn was harrowed with a spring-tooth harrow in the fall and 30 quarts of timothy was sown broadcast on the field and harrowed in with a spike-tooth harrow. The following spring 1 bushel of bluegrass seed was broadcasted on the field." During the winter, between seeding the timothy and bluegrass, one-half of the field was top-dressed with stable manure at the rate of 20 loads per acre. During the following winter the other half was top-dressed in the same manner. No more manure was applied until the fourth winter, when the entire 5 acres was top-dressed at one-half the rate used previously. In other words, instead of covering only one-half of the field at the rate of 20 loads per acre, the farmer covered the entire field at the rate of 10 loads per acre. The owner claims that after the first year this pasture has kept one horse, one cow, and one calf, or the equivalent of 2½ animal units. He makes the suggestion that if he were seeding again he would sow some red clover in addition to the timothy and bluegrass.

On another farm on the same soil type was found a 60-acre tract of which 20 acres was in timber in 1907. The timber was removed that year and the land cleared. After clearing, a mixture of bluegrass, redtop, red clover, alsike and a small percentage of alfalfa was sown broadcast and disked in. Six years later, or at

the time of our visit, this 20-acre tract showed a good stand of permanent pasture. However, the mixture of grasses was not uniform over the field. On some parts bluegrass covered the ground, and on others redtop predominated. The red clover had nearly all disappeared, and in some places the little white clover was rapidly coming in. Alsike showed on some parts of the field, but the farmer said that it was gradually disappearing. The alfalfa succeeded only on spots where brush had been burned.

Use of fertilizers and manure.—Thirty-five acres of this same tract, where all grasses of much pasture value had disappeared and briars and poverty grass were growing,was plowed for corn, which

A neglected pasture—Fertilizing and clipping would result in decided improvement.

was followed by oats. In 1909 the field was seeded to pasture with a grain drill, the same mixture being sown as on the new ground. To one-third of the land was applied 250 pounds per acre of fertilizer analyzing 1 percent ammonia, 8 percent phosphoric acid and 7 percent potash; to another third, a fertilizer carrying 10 percent phosphoric acid and 5 percent potash, and to the remaining third, steamed bone having 25 percent phosphoric acid. After 4 years this farmer thought that the 1-8-7 fertilizer had shown the most satisfactory results on the pasture. The 60 acres has been pasturing from 15 to 20 head of cattle since reseeded.

This farmer has top-dressed some of his pasture land at the rate of 10 tons of manure per acre, and thinks this doubles the yield of pasture for a single season, with good but decreasing effects for a number of years. He thinks a good permanent pasture may be obtained by an occasional application of manure, commercial fertilizer or lime, and that such a practice will maintain the pasture more economically than by plowing up and reseeding.

On a few farms, some spots in the permanent pasture had been top-dressed with strawy manure, or chaff from the barn floor had been hauled and scattered over bare places. In almost all instances the reports of this sort of treatment were favorable.

In the spring of 1913 experimental pasture plots were put out in Palmer Township, Washington County. On four of these farms the plots were located in old pasture fields, some of which had fairly good pasture on them, while others had little if any value. In each field five plots were reseeded with a pasture mixture (suggested by C. G. Williams). On Plot 1 nitrate of soda was applied at the rate of $2 worth per acre; on Plot 2 acid phosphate, at the rate of $2 worth per acre; on Plot 3 muriate of potash, at the rate of $2 worth per acre; on Plot 4 a mixture of those applied to Plots 1, 2 and 3, at the rate of $2 worth per acre. On Plot 5 manure was applied by scattering as lightly as possible. On two of these fields one-fourth of each plot was disked crosswise, and on two lime was applied crosswise over one-fourth of the plots.

The next year the plots treated with nitrate of soda showed well in the early part of the season. Since then they have shown no decided improvement. In 1916 more white clover and less poverty grass were growing on the plots treated with acid phosphate and manure than on the others. Likewise, all the plots where lime was applied showed more white clover and less poverty grass. The general conclusion from observing these plots for the 3 years is that phosphorus, lime or manure will show decided improvement, but that the use of nitrogen or potash makes no noticeable showing.

Clipping pasture.—On one farm the owner reported that the pasture land was in poor condition when he purchased the farm 12 years previous. Each year since he bought the farm he has clipped the pasture fields after harvest. In places where the mowing machine could not be used the scythe was brought into play. With practically no other treatment a great improvement was made in thickening the sod and increasing the carrying capacity of the fields.

RECENT TECHNICAL BULLETINS

Any of the following bulletins in the original series may be obtained by writing to the Experiment Station, Wooster:

No. 290—Varieties of apples in Ohio: Descriptions of the trees and fruit of 116 Ohio apple varieties, along with results of storage tests, records of blooming periods, disease susceptibility, apple sections of Ohio, and a discussion of quality in apples.

No. 291—Experiments with laying hens: Comparisons of lots of hens kept on range and in confinement; of lots fed variety and simple rations, and of lots fed various amounts of protein in the ration Abstract in June Monthly Bulletin.

No. 292—Sulphur in relation to soils and crops: The sulphur supply of soils, results of field and laboratory tests with sulphates and with other forms of sulphur on various crops, and the influence of sulphur on the production of acidity and the solubility of phosphorus.

No. 293—The grape-berry worm: Complete description, life history and habits of the insect, results of experimental spraying tests in Lake Erie section in 1907-15, with recommendations for control. Abstract in May Monthly Bulletin.

No. 294—Wool studies: Results of experiments to determine the effect of washing before shearing, and of the time of shearing, on the yield of grease wool and of scoured wool and on the rate of gain in live weight. Abstract in May Monthly Bulletin.

No. 295—Mineral metabolism of the milch cow: A study of the mineral income and outgo of the milch cow on common practical rations, with detailed tables of experimental data. Abstract in June Monthly Bulletin.

No. 296—Ohio weather for 1915: Maps and summary tables giving the temperature and precipitation during the year.

No. 297—The clover leaf tyer: Food plants, character of damage, life history and habits, complete description and control measures included. Abstract in June Monthly Bulletin.

No. 298—Wheat experiments: Rotation tests, results of fertilizer treatments and of cultural methods, relation of weight of kernel to yield, variety tests, improving wheat by selection. Abstracts in July and August Monthly Bulletins.

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